3D Printing

How Much Will It Improve the DoD Supply Chain of the Future?

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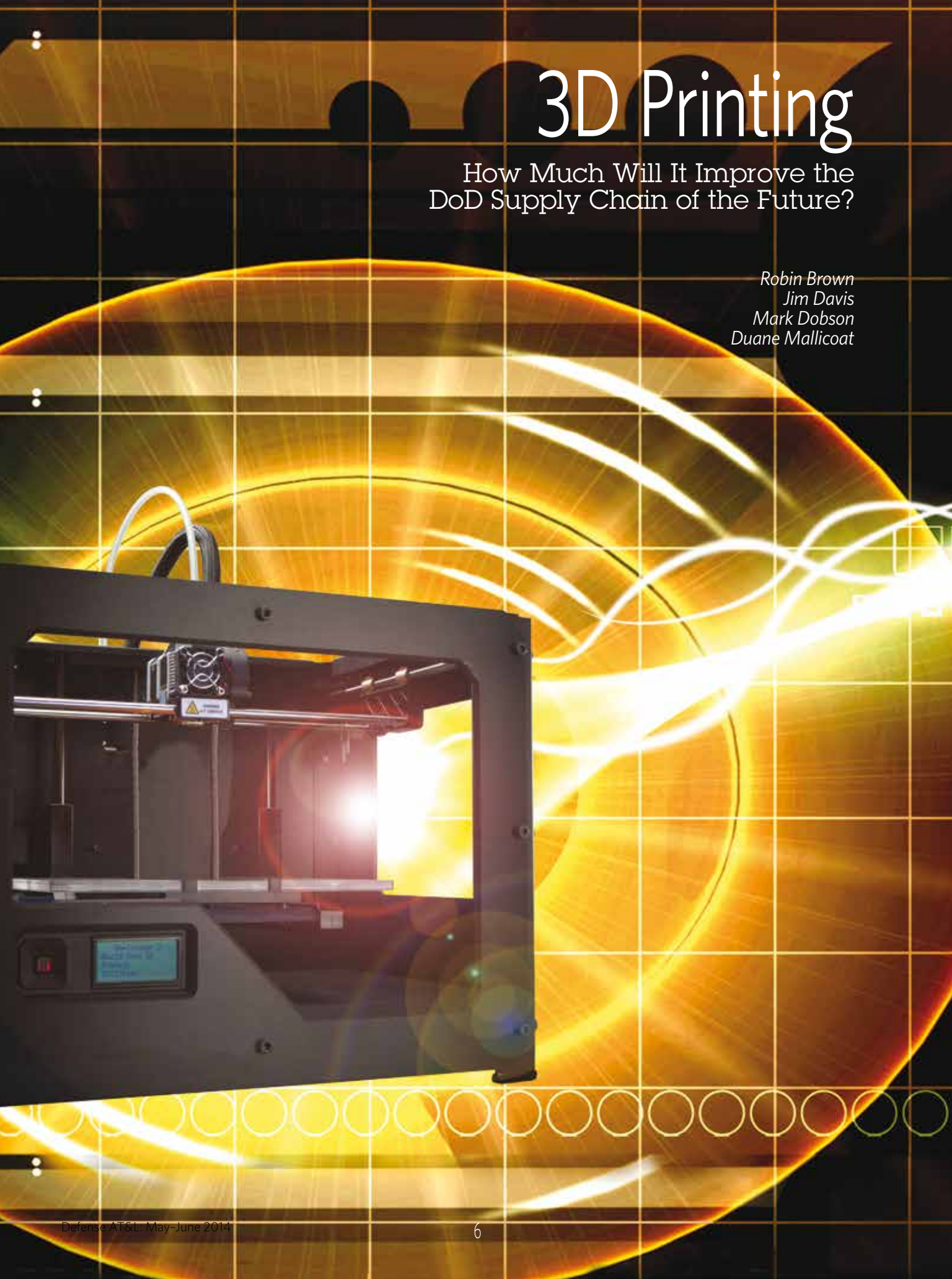

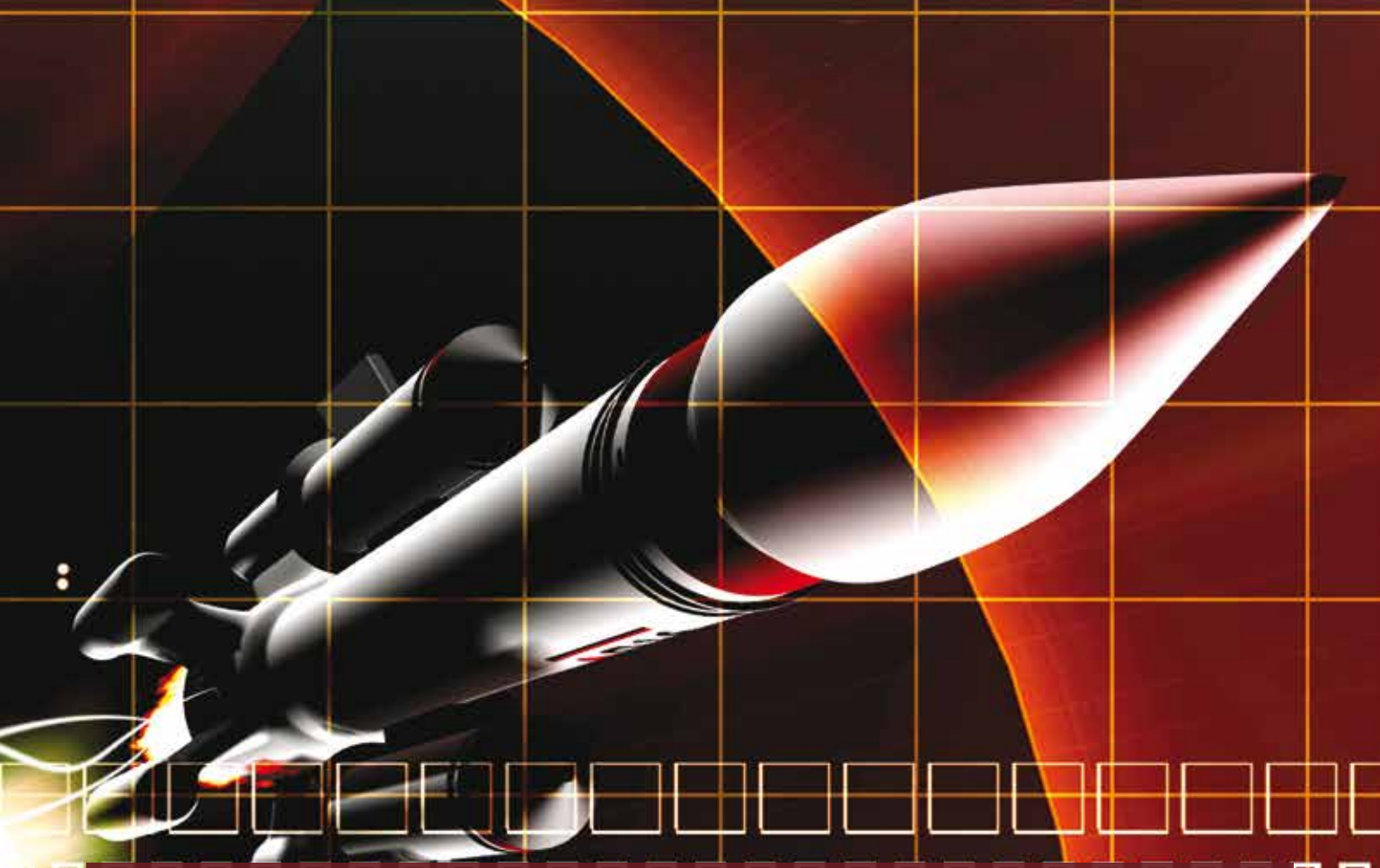

"Captain's log, star date 2821.5. On route to Makus III with a cargo of medical supplies. Our course leads us past Murasaki 312, a quasar-like formation. Vague, undefined, a priceless opportunity for scientific investigation. On board is Galactic High Commissioner Ferris, overseeing the delivery of the medicines to Makus III."

Star Trek fans might recall these lines from the second episode of the original *Star Trek* television series that aired in 1966. The show, produced by Gene Roddenberry, challenged the audience with a string of science fiction technologies that many thought simply impossible. A handheld device that allows individuals to talk with each other over vast distances without the use of wires; an elevator that is voice activated; and a fan favorite, a machine (the replicator) capable of making any object that you need (including meals). Now this last technology is really over the top.

Those of us who live in the Department of Defense (DoD) supply chain management arena, however, are keenly aware that throughout the *Star Trek* series, there is never an appearance by the *Enterprise* supply officer. The absence of a supply officer may be a bit unnerving, but then again, *Star Trek* is science fiction and certainly not the harbinger for the end of supply officers and the supply chains they manage. There will always be storerooms filled with inventories and always a need for a supply officer or logistics officer who can master DoD's labyrinth of a supply chain. If history teaches us nothing else, it tells us that while there will always be a need for a supply chain, the chain itself will constantly be changing—consider it a state of evolution or, in some cases, revolution.

Throughout history, the ability to wage war has been rooted in a robust logistics operation. A key element to this logistics doctrine is the strength of the supply chain. Commanders who understood the importance of their

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supply chain were often successful, while those who ignored weaknesses in their chain were dealt devastating blows. From the days of Genghis Khan to the recent conflicts in Iraq and Afghanistan, the world has witnessed classic examples of successes and failures in logistics. This reference to history is critical to recognizing that the elementary concepts of supply chain management have been around for thousands of years. However, the tools and techniques used have changed dramatically over time, and we can expect nothing less in the future.

Current State of DoD's Supply Chain

As one might imagine, the present DoD supply chain is large and complex. For many, the sheer size and scope of the operation is beyond comprehension. There are myriad organizations, in both government and private industry, that are integral to DoD's supply chain. One organization that plays a pivotal role is the Defense Logistics Agency (DLA). DLA manages an inventory of more than 5 million line items with annual sales in excess of $44 billion. The inventory is warehoused throughout the world in more than 75 million square feet of storage space (the equivalent of nearly 1,300 football fields). In addition, DLA processes more than 100,000 requirements every day.

With budgetary pressures being applied across all of DoD, the supply chain becomes a target-rich environment for identifying efficiencies and reducing both the logistics footprint and overall costs. When we consider that in fiscal year 2012, DLA disposed of more than 2.5 million line items of material, it's easy to understand the desire for a more efficient chain. Finally, even with such a massive inventory, we still find ourselves with critical shortages of spare parts. Diminishing manufacturing sources and material shortages (DMSMS) is a thorn in the side for just about every weapon system, often leaving the warfighter frustrated with a multibillion-dollar supply chain that constantly faces challenges in trying to provide a time-sensitive "critical" component. All these factors in the current DoD supply chain naturally drive pressures towards greater and greater efficiencies.

By now you are thinking that the authors can't possibly be suggesting the elimination of supply depots and the millions of square feet of storerooms. Surely we can all take a little comfort in knowing that some things on *Star Trek*, such as the replicator, exist purely in the realm of science fiction. Nobody is crazy enough to be out there trying to invent such a machine—or have they already done so?

DoD Enters the 3D Printing Arena

First let's set the stage by defining 3D printing. To put it simply, 3D printing is a manufacturing process in which materials (plastic, metal or other) are laid down, layer by layer, to form a three-dimensional object. It is deemed an additive process where the object is built up from scratch, which is why 3D printing is also referred to as "additive manufacturing." This process is the opposite of the more traditional subtractive manufacturing process, where material is cut, drilled, milled or machined off. 3D printers employ a variety of techniques and materials, but they share the ability to turn digital files containing 3D data—whether created on a computer-aided design (CAD) program or from a 3D scanner—into physical objects.

3D printing can be used to create models and prototypes quickly from CAD drawings, but lately they're increasingly used to make final products as well. The items made include shoe designs, furniture, wax castings for jewelry, tools, tripods, gift and novelty items, toys and, most recently, aviation engine components.

Riding the 3D Printing Wave

Some people in the industry think that additive manufacturing will overturn many of the economics of production, because the process pays no heed to unit labor or traditional economies of scale. Designs can be quickly changed because the technology enables flexible production and customization. Software can be used to predict exactly how a part will perform. General Electric is so positive about the capabilities of 3D printing that it is using the process to make jet engine parts. Morris Technologies (recently acquired by General Electric) uses a number of 3D printing machines in conjunction with a technology called laser sintering. This involves spreading a thin layer of metallic powder onto a build platform and then fusing the material with a laser beam. Laser sintering is capable of producing all kinds of metal parts, including components made from aerospace-grade titanium.

Meanwhile, Airbus partnered with the University of Exeter to open a 2.6 million euros Centre for Additive Layer Manufacturing in 2011. Its mission is to explore the 3D printing opportunities relating to aircraft. Their research goal is to investigate the production of a plane constructed entirely of 3D printed parts.

In the automotive industry, Ford showed off the latest version of its hybrid car at the Atlanta Auto Show in March 2013. The car's drive train, transmission, and other key parts were all produced using 3D technology.

The U.S. government has embarked on a $60 million project to form a 3D printing institute. The Air Force Research Laboratory is serving as the contracting agent for this DoD initiative. The ultimate goal is to help address warfighter requirements at the best value for the taxpayer while transitioning advanced manufacturing technology into the DoD and commercial supply chains.

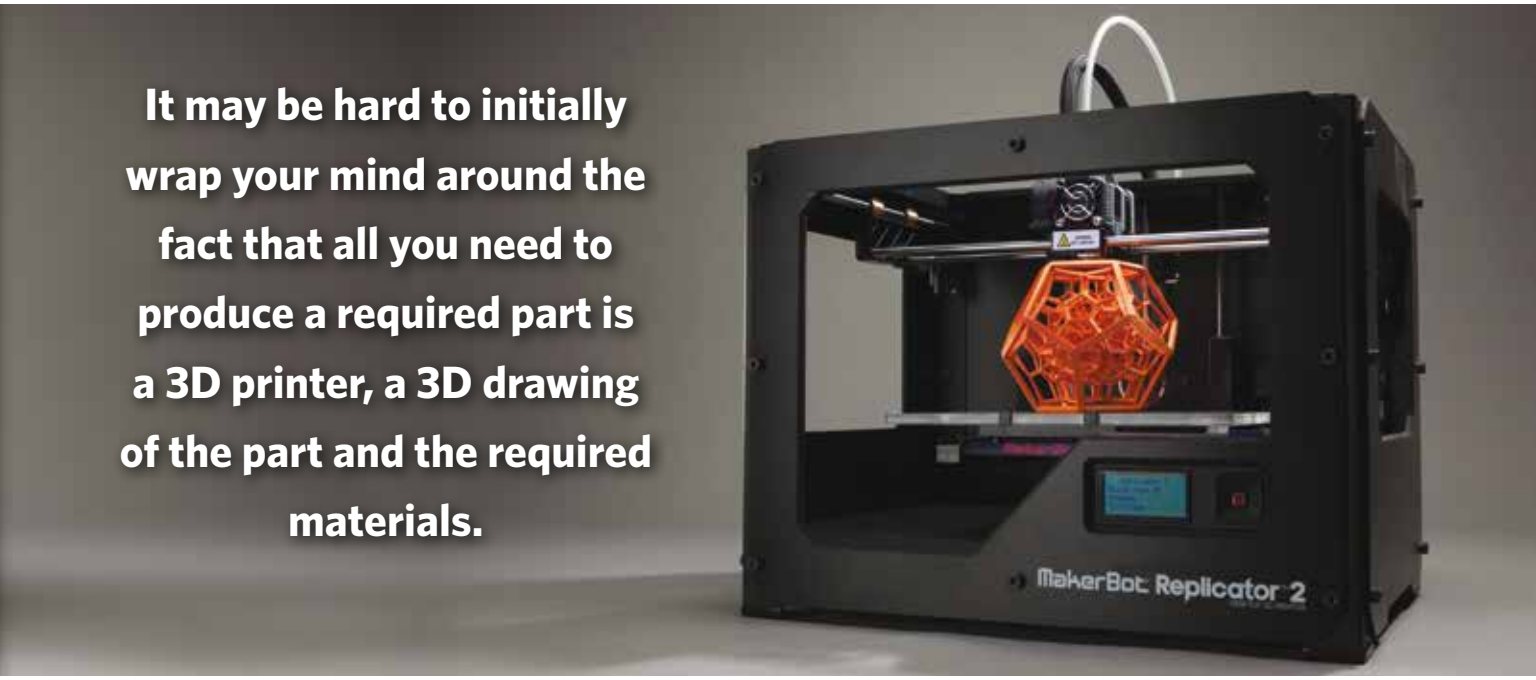
All in all, these developments suggest a very promising future for a technology that has a great deal to offer. There is speed (design to production), flexibility, elimination of production run requirements (economies of scale), and what is sure to be far-reaching effects on transportation pipelines. Exactly what, however, does the average DoD weapon system program office gain from 3D printing, and how will 3D printing help make the program office product support manager's (PSM) job a little easier?

The PSM's View of 3D Printing

Even a cursory overview of the value that 3D printing technology would bring to the ever-demanding supply chain management profession would make any PSM giddy. Dozens of benefits instantly come to mind, but for now, let's look at just one.

One issue that causes significant consternation for the PSM—and presents a serious threat to mission accomplishment—is supply chain forecasting. In order to fully understand just what a game changer 3D printing could be, one must have a reasonable understanding of how the supply chain business is currently conducted. "Peeling back the onion" on supply chain forecasting reveals one very important driving factor to consider: funding. Of course, everyone understands that fiscal constraints play heavily in all DoD business decisions in today's environment. It is also safe to say that, in a risk-averse environment, all PSMs would love to have at least one of everything on the shelf, if cost were not an issue. Therein lies the PSM's dilemma: just exactly what parts are required on the shelf and, of even bigger concern, when will those parts be needed? Given that funding is a constraint, what demand signal does the PSM send to the supply chain to indicate which parts must be stocked on the shelf? The PSM will do the supportability analysis and with some confidence predict what spare parts should be required over a given period. However, let's say that during that predetermined period the supply system receives zero demand for a given part. Without being able to show demand, the system dries up and the chain cannot justify continued stocking or procurement actions for that part. Sure there are insurance items, and cases can be made to retain material, but holding material comes with a price, as all those who have taken basic business courses know. The trade-offs are simple. We must balance inventory holding costs with the risk associated with a stock out of a part that experiences little to no demand.

Unfortunately, as alluded to, the supply chain forecasting process is not 100 percent precise. Let us suppose that one day, say a couple of years after a certain part is no longer carried by the supply system, there is an urgent demand for that very part. At this point, the lead time to acquire the part can be between 12 and 18 months—or more! Why? In many cases, the process of acquiring the required part is back to square one. The supply chain must start performing market research, creating requests for information, developing a contract and a statement of work, specifying order quantities, negotiating with the prospective vendor and so forth. All this takes a great deal of time. Additional issues to consider are the lead time required for acquiring materials and the actual manufacturing of the part. Of course, this scenario doesn't even take into consideration the possibility that there may be DMSMS issues. This scenario plays out hundreds, if not thousands, of times a day throughout DoD.



Enter 3D printing. It may be hard to initially wrap your mind around the fact that all you need to produce a required part is a 3D printer, a 3D drawing of the part and the required materials (qualifying the specific part for use notwithstanding). Needless to say, this type of technology could cure a great many of the PSM's headaches. Just a few of the benefits include such things as nearly eliminating traditional contract actions, limiting the need for warehousing and storing inventory, and reducing the spending of precious resource dollars on surplus parts. Perhaps most important, however, 3D printing technology might be the answer to the PSM's greatest problem: diminishing manufacturing sources and material shortages (DMSMS).

Is 3D Printing the Answer to DMSMS Challenges?

A DMSMS issue is the loss, or impending loss, of manufacturers or suppliers of items, raw materials or software. DoD loses a manufacturer or supplier when that manufacturer or supplier discontinues production of needed components or raw materials, or when the supply of raw material no longer is available. This can be caused by many factors that significantly affect the DoD supply chain and industrial base, such as low-volume market demand, new or evolving science or technology, detection limits, toxicity values, and regulations related to chemicals and materials. An old logistician's proverb—which begins with "for want of a nail the [horse] shoe was lost" and ends with the kingdom being lost "all for the want of a nail"—illustrates that the lowest level in a system's hierarchy can affect the entire system.

DMSMS challenges range from the introduction of counterfeit parts to shifting repair philosophies and an ever-faster product life cycle that is greatly influenced by the commercial sector. So, with all that said, perhaps instead of buying a part for inventory, we buy the rights to make our own on demand? Just think of all the benefits that could be realized from a "buy on demand" supply system philosophy. Surely it's not as simple as making your own parts in the back shop and completely eliminating DMSMS from our future vocabulary. There is a long list of issues that need to be addressed. Configuration management along with the ever elusive data rights issues are merely the tip of the iceberg when contemplating a "make your own part" supply system. But don't give up on 3D printing just yet. The challenges we face are not really any different than those arising from past technological innovations that shifted the DoD supply chain. Paradigms will shift, statutes and regulations will be revised, and the barriers and speed bumps limiting 3D printing will be resolved.

So Where Do We Go Next?

3D printing gives a whole new meaning to "Just in Time" supply chain management. But are we ready today to stop buying spares for our warehouse shelves and to sell off all of our warehouse real estate? The answer is obviously no. We hope, however, that this article has captured the reader's imagination about what we can start doing now in the world of 3D printing and how we must be proactive in the insertion of this technology into DoD's supply chain. There is a definite "ground swell" around 3D printing. Hardly a day goes by without reading about a new opportunity to leverage this technology. Here is a golden opportunity for the DoD acquisition community to come together with industry and make 3D printing a commonplace occurrence in DoD's supply chain. It will take a truly coordinated effort among all stakeholders for 3D printing really to take off. To quote Gene Roddenberry, "It isn't all over; everything has not been invented; the human adventure is just beginning."

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